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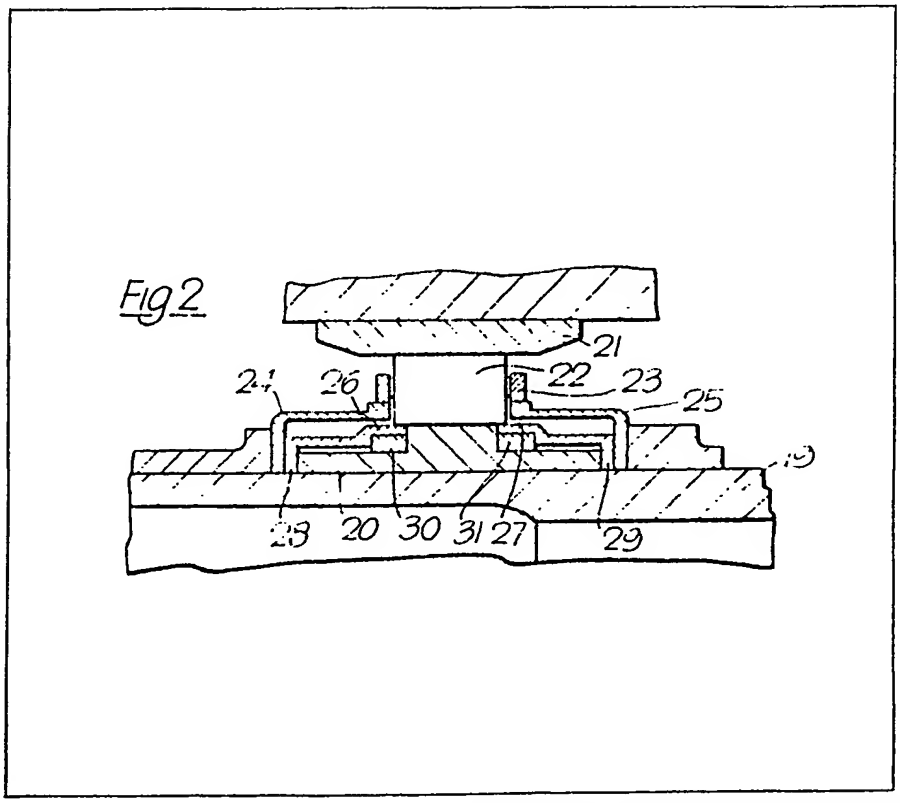
(54) **Rolling Bearing**

(57) A bearing has an inner race (20) an outer race (21) and rollers (22) in a cage (23) therebetween. To prevent skidding of the rollers at high speeds of rotation of the bearing, the inner race is provided with auxiliary bearing tracks (26,27) which are radially movable under centrifugal loads on loading segments (30,31) disposed beneath the tracks.



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

GB 2 012 008 A

Fig.1.

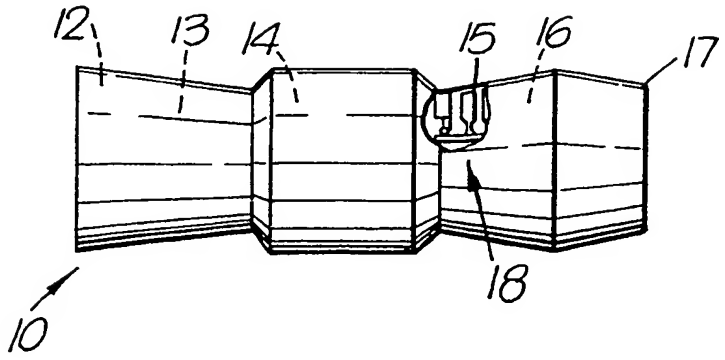


Fig.2.

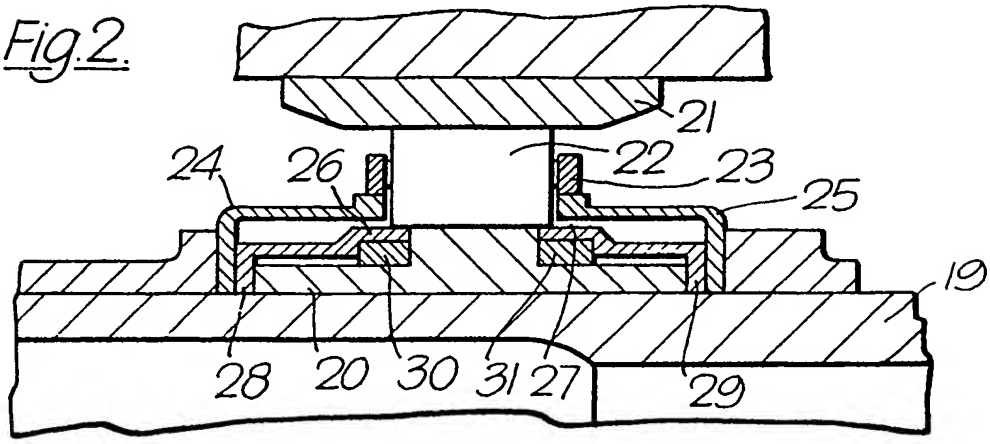


Fig.3.

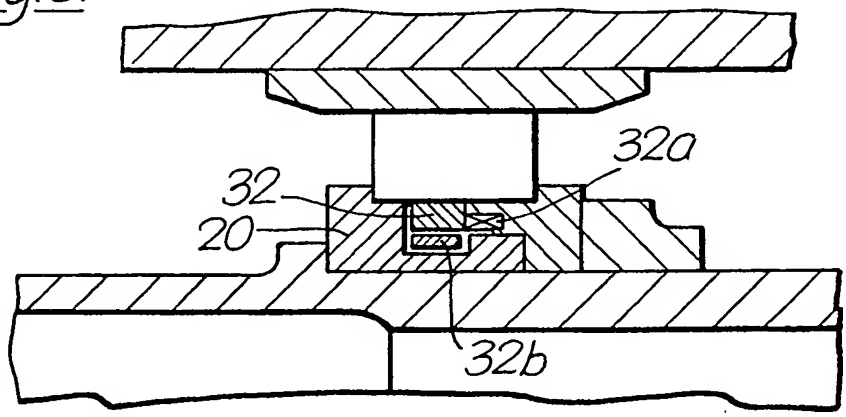
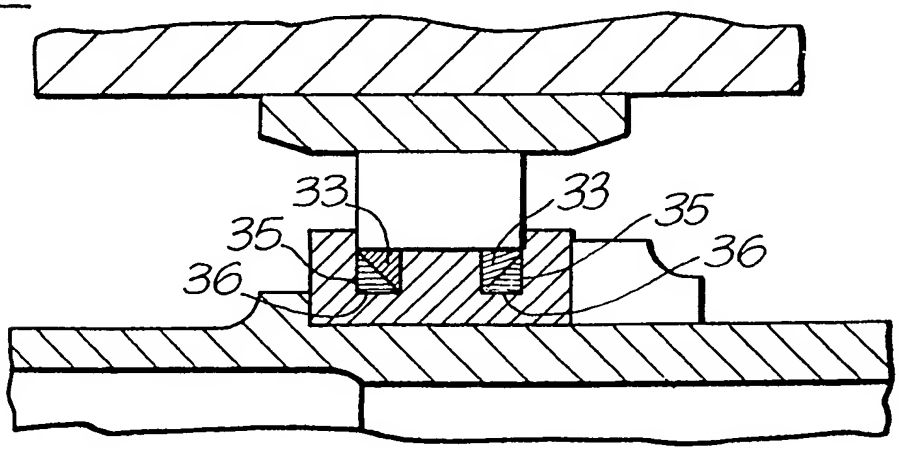


Fig.4.



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SPECIFICATION

Improvements in or relating to bearings

This invention relates to bearings and more particularly to improved bearings suitable for use in a gas turbine engine.

During operation of ball and roller bearing in gas turbine engines conditions of operation can arise in which some of the rolling elements lose contact with the bearing races thus resulting in skidding of the rolling elements. There are two basic factors which lead to skidding of the bearing at high operational speeds. Firstly, during the relative rotation of the bearing and associated structure, the bearing is always subjected to small out of balance forces and these can result in unequal radial loading of the bearing. This unequal radial loading results in some of the rolling elements being put into compression thus increasing the clearance between the remainder of the rolling elements and the tracks on which they run which can lead to skidding. Alternatively, skidding may occur at high speeds due to the frictional tractive forces which drive the rolling elements becoming insufficient to entirely overcome the oil drag on them. This tends to prevent the rotation of the rolling elements thus causing skidding. Skidding is obviously detremental to the efficient operation of a bearing as it results in both high wear both on the bearing race and the rolling elements and also leads to overheating of the bearing.

According to the present invention, a bearing comprises a radially inner bearing race, a radially outer bearing race and a plurality of rolling elements arranged therebetween, the radially inner bearing race including at least one auxiliary bearing track which is capable of increasing or decreasing in diameter under the action of centrifugal forces acting thereon, or on loading means disposed radially inwardly thereof, during operation of the bearing.

In this way, during slow speed operation of the bearing the rolling elements contact both the radially inner and radially outer bearing races, but during high speed operation the rolling elements are urged into contact with the radially outermost bearing race by the expanding auxilliary bearing track or tracks.

The auxiliary bearing track or tracks may each be divided into part-annular segments which together define a bearing surface. Annular loading segments are provided which are manufactured from a material having a higher density than the material of the track segments and which are disposed beneath the track segments, such that during operation of the bearing the centrifugal force acting upon the loading segments exerts a force on the track segments to increase the diameter of the track.

Alternatively, the auxiliary bearing track or tracks may each comprise a continuous annular member defining a bearing surface, and beneath which are secured a plurality of loading segments of a material having a higher density than that of the auxiliary bearing track such that during operation of the to centrifugal force acting upon the segments of dense material.

Preferably the dense material from which the loading segments are made is a relatively dense tungsten based alloy.

An embodiment of the invention will now be more particularly described by way of example only and with reference to the accompanying drawings, in which:-

Figure 1 shows a pictorial view of a gas turbine engine which has a portion of its turbine casing broken away to disclose a diagrammatic embodiment of the bearing made in accordance with the present invention;

Figure 2 shows a cross-sectional view in greater detail of the bearing shown diagrammatically at Figure 1; and

Figures 3 and *4* both show cross-sectional views of bearings made in accordance further embodiments of the present invention.

Referring now to Figure 1 of the drawings, a gas turbine engine shown generally at 10 comprises in flow series, a low pressure compressor 12, a high pressure compressor 13, combustion equipment 14, a high pressure turbine 15, a low pressure turbine 16 the engine terminating in an exhaust nozzle 17. The low pressure compressor 12, and low pressure turbine 16, and the high pressure compressor 13, and high pressure turbine 15 are each respectively mounted on coaxially arranged low and high pressure engine main shafts. A bearing which supports the high pressure engine shaft from the fixed structure of the engine and which forms an embodiment of the present invention, is shown at 18 within the cutaway casing turbine portion of the casing.

A more detailed view of the bearing shown generally at 18 is illustrated in Figure 2 in which a portion of the engine's high pressure main shaft is shown at 19. The bearing 18 consists of a radially inner main bearing race 20 secured to the shaft 19, a radially outer bearing race 21, and a plurality of rollers 22 arranged therebetween. A roller cage 23 is arranged within the annular space defined between the races 20 and 21, the cage serving to ensure that the rollers 22 remain equally spaced between the bearing races. The cage 23 is maintained concentric with the races 20 and 21 by means of two cylindrical support members 24 and 25 which are secured to the high pressure shaft 19.

During low speed of the bearing, the rollers 22 will remain in close contact with both radially inner and radially outer bearing races 20 and 21, However, if the bearing is subjected to a higher speed, the rollers 22 may lose contact with the inner race 20. To prevent this occurance, two auxiliary inner bearing tracks 26 and 27 are provided on the inner bearing race one at each axial end thereof. The two tracks 26 and 28 are either secured to, or from a part of, two cylindrical members which terminate in radial flanges 28 and 29 and which are both located upon and secured to the shaft 19. Beneath the auxiliary tracks, i.e. in annular spaces formed between the tracks 26 and 28 and the main inner race 20, are arranged a plurality of part-annular loading seg-

annular loading member in each space. The loading segments are manufactured from a dense material such as for example, a tungsten based alloy.

When, therefore, the bearing is run in a high speed condition the centrifugal forces acting upon the relatively dense loading segments 30, 31 will exert a force on the auxiliary bearing tracks 26 and 27. This force together with centrifugal forces on the auxiliary tracks themselves will increase the diameter of the auxiliary tracks 26 and 27 such that they will remain in contact with the rolling elements 22. The auxiliary tracks are continuous annular tracks although they may also be formed in a plurality of segments.

Figure 3 shows an alternative embodiment of the invention and in this instance a single auxiliary bearing track 32 is provided within the mid-portion of the radially inner race 20. The auxiliary track is continuous and is provided with dogs 32*a* by means of which it is secured to the radially inner main bearing race 20 thus preventing relative rotation between the two parts. In an annular space defined beneath the auxiliary bearing track i.e. between the auxiliary bearing track 32 and the main inner race 20 are provided a plurality of loading segments of dense material 32*b*. This bearing also functions in exactly the same way as that described in previous embodiment.

Figure 4 shows a further embodiment of the invention and in this instance the radially inner bearing race 20 carries two auxiliary tracks in annular recesses 32 within it. In this example the auxiliary tracks each comprise a continuous member 33 which is triangular in section, one of the sides of which is arranged to provide a bearing surface, and the hypotenuse 34 of which is arranged to face inwardly. A plurality of loading segments 36 of dense material are situated beneath the members 33, each of which has a radially outwardly facing surface angled to co-operate with the surface 34 provided upon the members 33.

As will be seen from the drawing, when the bearing is rotated the centrifugal force on the segments 36 will cause them to exert a force normal to the angled surface 34 on the auxiliary tracks such that they are forced into contact with the rollers and one side-wall of the recess 35 in the main inner race. In this way the auxiliary races are friction driven from the main race and no driving dogs are needed as in Figure 3. This embodiment therefore also functions in a similar way to that of the previous embodiments.

CLAIMS

1. A bearing assembly comprising a radially inner bearing race, a radially outer bearing race, and a plurality of rolling elements arranged therebetween, the radially inner bearing race including at least one auxiliary bearing track which is capable of increasing or decreasing in diameter under the action of centrifugal forces acting thereon, or on loading means disposed radially inwardly thereof, during operation of the bearing.

2. A bearing assembly as claimed in claim 1 and in which auxiliary bearing tracks are provided one at each axial end of the inner race.

3. A bearing assembly as claimed in claim 1 and in which an auxiliary bearing track is formed centrally of the inner race.

4. A bearing assembly as claimed in any preceding claim and in which an annular space is defined radially inwardly of each auxiliary bearing track in which are positioned loading segments of a material of greater density than the material of the auxiliary bearing track whereby during operation of the bearing centrifugal forces on the loading segments increase the diameter of the auxiliary bearing track.

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